Monitoring Astronaut Performance Using Robotic Exoskeletons

Completed Technology Project (2015 - 2018)

Project Introduction

An extended period of space exploration has deleterious effects on the neuromuscular system. Sensorimotor impairments can hinder an astronaut's performance by reducing coordination and inhibiting fine manual control of vehicles and devices. Although astronauts undergo Functional Task Testing (FTT), the current test for fine motor control (a pick-and-place peg test) does not quantitatively identify the underlying neuromuscular deficiencies that diminish the astronauts' hand function. Thus, a more sophisticated test is needed to precisely and systematically measure and assess hand function in astronauts. I propose the development of a hand exoskeleton-based astronaut assessment. My plan is to prepare a hand exoskeleton for human subject studies, derive metrics that will objectively assess hand function, and introduce a novel hand assessment test with the exoskeleton. To prepare the hand exoskeleton, I will integrate surface electromyography (sEMG) to analyze muscle activations. I will then derive motor performance metrics based on position, force, and sEMG sensor data from the hand exoskeleton, normalize the metrics, and test the metrics for reliability. Lastly, I will determine the correlations between the hand exoskeleton metrics and standard therapist-administered assessment scales using a combination of regression analysis, artificial neural networks, and principal component analysis. I will use the results to propose a novel hand exoskeleton-based hand assessment test. The hand exoskeleton assessment test will be used to analyze the sensorimotor degradation of hand performance resulting from prolonged visits to space. The device will quantitatively evaluate hand function, digitize astronaut performance data, and communicate the information to clinicians on earth. By assessing astronaut hand function in space, the hand exoskeleton will aid in recognizing the onset of abnormal hand performance. This will help ensure space mission safety during flight by determining astronauts' fitness-for-duty.

Anticipated Benefits

N/A

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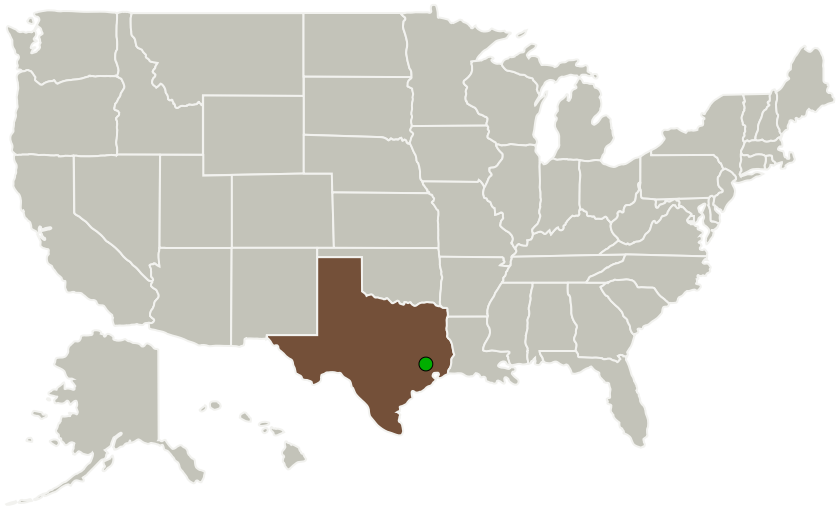
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
The University of Texas at Austin	Lead Organization	Academia	Austin, Texas
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations
Texas

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

The University of Texas at Austin

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Ashish D Deshpande

Co-Investigator:

Kaci E Madden

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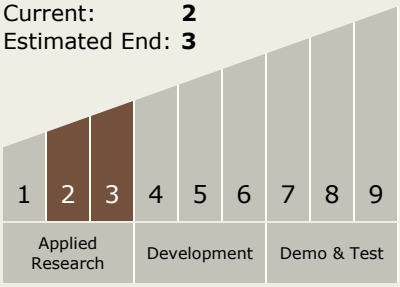
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.2 Modeling
    - TX11.2.3 Human-System Performance Modeling

Target Destinations

Earth, The Moon